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DIAGNOSIS OF DOMINANT MITRAL STENOSIS OR REGURGITATION USING AMYL NITRITE

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It is sometimes difficult to estimate the degree of regurgitation in combined mitral disease, and every new method that helps its evaluation is welcome. Having obtained good results with drugs influencing murmurs in mitral disease (Endrys and Bártová, 1962) we began to use amyl nitrite, which affects the pressure in the left atrium, in an attempt to obtain more reliable diagnostic results. This drug was considered suitable, since it causes the diastolic murmur to increase in mitral stenosis and the systolic murmur to decrease in mitral regurgitation (Vogelpoel *et al.*, 1959; Endrys and Bártová, 1962).

Subjects and Methods

The pressure in the left atrium was recorded in 25 patients after catheterization of the left heart percutaneously and transseptally, as described elsewhere (Steinhart and Endrys, 1960; Endrys and Steinhart, 1962). In two patients pulmonary capillary pressure was determined instead of pressure in the left atrium. An Elema electromanometer and a 2- or 4-channel Elema Mingograph type 24 or 42 oscillograph was used for pressure recordings.

In some patients the pressure in the femoral artery or left ventricle was recorded simultaneously as well. Amyl nitrite (approximately 0·4 ml.) was inhaled for 30–40 seconds, so that there was an increase in pulse rate and reddening of the skin. The pressure was recorded during held normal expiration before inhalation of amyl nitrite, and then every 15 seconds for one minute, and at two, three, and four-minute intervals. Changes in maximum, minimum, and mean pressure in the left atrium were measured, as were femoral arterial or left ventricular pressure pulses.

Twenty-seven patients with mitral heart disease were examined. Group 1 consisted of 9 patients with pure mitral stenosis, and Group 2 of 9 patients with stenosis accompanied by slight regurgitation. Group 3 contained 8 patients with dominant mitral regurgitation, and in one there was pure mitral regurgitation with aortic stenosis.

The diagnosis was confirmed in all patients with pure or dominant stenosis by cardiotomy. In 3 patients of Group 3 dominant regurgitation was also verified by operation: these were patients with traumatic mitral regurgitation following operation. In the remaining 6 patients, dominant or pure mitral regurgitation was diagnosed by left-sided angiocardiography and by recording the dilution curves from the left atrium, after injection of dye into the left ventricle (Steinhart and Endrys, 1960; Endrys and Steinhart, 1962).

All patients in Group 3 showed the typical clinical picture of hæmodynamically significant mitral regurgitation.

Results

A change in left atrial pressure was observed following amyl nitrite administration in all but one patient, and simultaneously the heart rate increased. Maximum changes in pressure and rate were observed 30 or 45 seconds after the start of amyl nitrite inhalation. In all patients with mitral

stenosis, or mitral stenosis with hæmodynamically insignificant mitral regurgitation, there was a rise in left atrial pressure that varied from 4 to 27 mm. Hg, i.e. 15 to 117 per cent of the initial value. In patients with dominant regurgitation there was always a fall in left atrial pressure of 4 to 21 mm. Hg, i.e. 18 to 68 per cent of the initial value. In one patient there was no pressure change in the left atrium following amyl nitrite inhalation, the heart rate remained unchanged, and there was no reddening of the skin. Since no effect of amyl nitrite appeared in this patient, the result cannot be evaluated; the patient was excluded from the series.

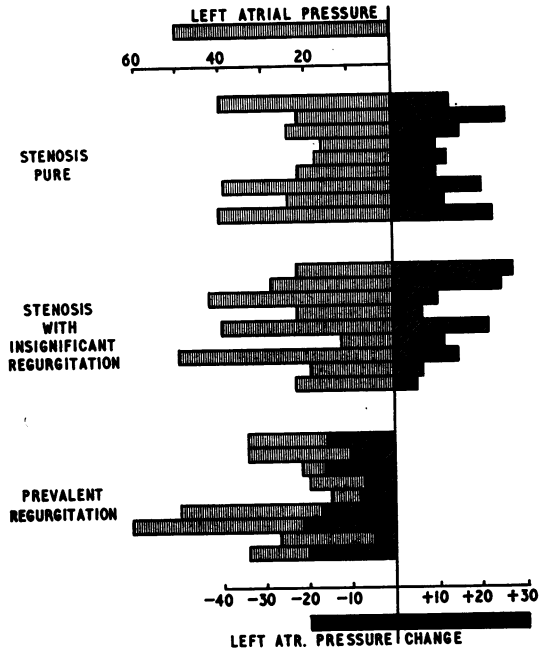

FIG. 1.—Graphic representation of left atrial pressure changes in mitral heart disease. In predominant or pure stenosis the pressure rises, while in predominant regurgitation it falls.

DISCUSSION

Mitral stenosis leads to an increase in pressure in the left atrium and to the formation of a diastolic pressure gradient between the left atrium and left ventricle. This gradient depends on the degree of mitral stenosis and on the amount of blood flowing through this orifice per unit time. In mitral regurgitation diastolic flow through the mitral orifice is increased by the volume of regurgitating blood. Hence a significant regurgitation causes a pronounced pressure rise in the left atrium and in the atrio-ventricular pressure gradient, even if the stenosis is relatively small (Belobrádek, 1961; Samet, Bernstein, and Litwak, 1958; Zoob, Rockney, and Cleland, 1958). The same diastolic pressure gradient may thus be found in the three groups under discussion. The amount of regurgitant blood in mitral regurgitation depends on the valve area through which the regurgitant stream flows into the left atrium, the duration of systole, and the pressure difference between the left ventricle and left atrium (Wiggers, 1949; Wiggers and Feil, 1922; Rodbard and Williams, 1954; Braunwald, Welch, and Sarnoff, 1957; Braunwald, Welch and Morrow, 1958; Crawshaw *et al.*, 1954). Of the three factors affecting the degree of regurgitation the size of the systolic atrio-ventricular pressure gradient is most easily affected by changing the systolic pressure in the left ventricle. This has been done experimentally and clinically by giving noradrenaline (Braunwald *et al.*, 1958), methoxamine, or compressing the aorta (Braunwald *et al.*, 1958; Crawshaw *et al.*, 1954). Under these conditions the pressure in the left atrium rises.

Other published data (Braunwald *et al.*, 1958), and our own unpublished experience, show that after the application of noradrenaline the left atrial pressure in mitral stenosis also increases. Left atrial pressure rises in both instances, stenosis or regurgitation, even though the rise in the second group is higher. Hence we used amyl nitrite to lower left ventricular pressure for diagnostic purposes.

Our results (Fig. 1) show that the pressure in the left atrium increased in patients with pure mitral stenosis or stenosis with only insignificant regurgitation (Fig. 2 and 3), while in patients with pure or dominant regurgitation the pressure decreased (Fig. 4 and 5). The rise in pressure, after amyl nitrite in mitral stenosis, may be explained by a considerable rise in heart rate with shortening of diastole, and thus a shortening of the period in which blood flows from the left atrium into the ventricle. Thus flow through the opening is increased per unit time. Another factor that may play a role is the rise in minute volume due to amyl nitrite (Beck *et al.*, 1961). The fall in pressure in the left atrium in regurgitation is due to a decrease in the volume of regurgitant blood, as the

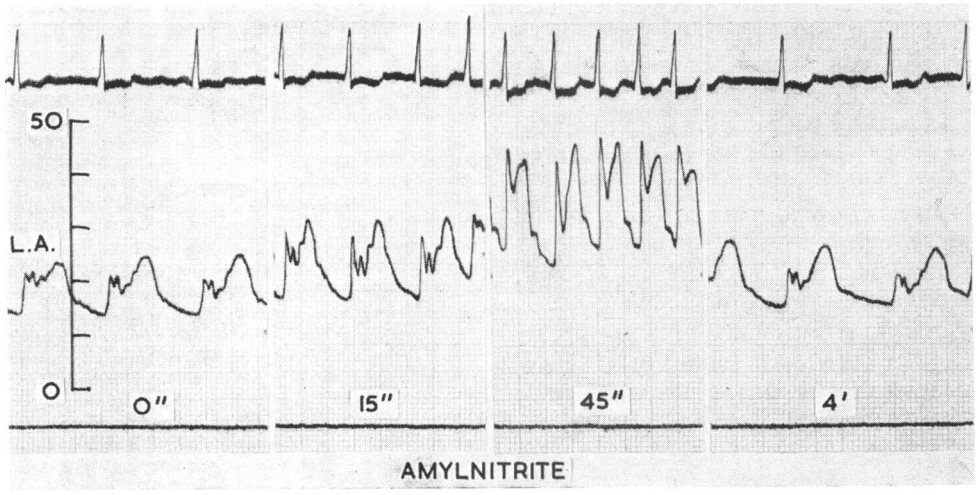

FIG. 2.—Left atrial pressure in mitral stenosis; 15–45 seconds after beginning of amyl nitrite inhalation there was a significant rise in pressure.

atrio-ventricular systolic pressure gradient is decreased. This is due to peripheral vasodilatation, with a fall in systemic and in left ventricular pressure. The response of the atrial pressure to amyl nitrite is basically different in patients with stenosis from those with prevalent regurgitation; this pharmacological test helps to clarify the cause of the pressure rise in the left atrium in mitral heart disease, and to distinguish dominant stenosis from regurgitation.

The method is limited to some extent by the fact that following amyl nitrite the expected fall in arterial pressure, which is the basis of hæmodynamic changes on which the test is based, may not

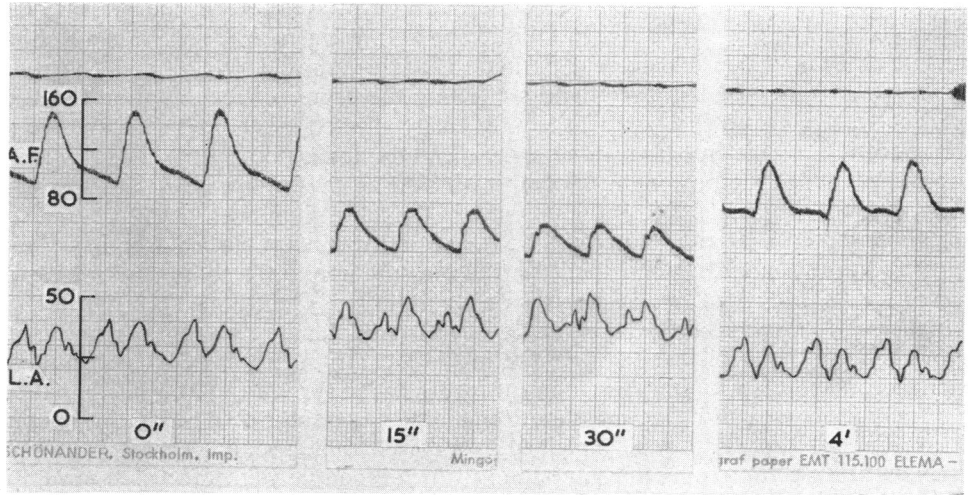

FIG. 3.—Simultaneously-registered pressure in femoral artery (A.F.) and left atrium (L.A.) in mitral stenosis. After amyl nitrite the pressure in the femoral artery fell, while in the left atrium it rose.

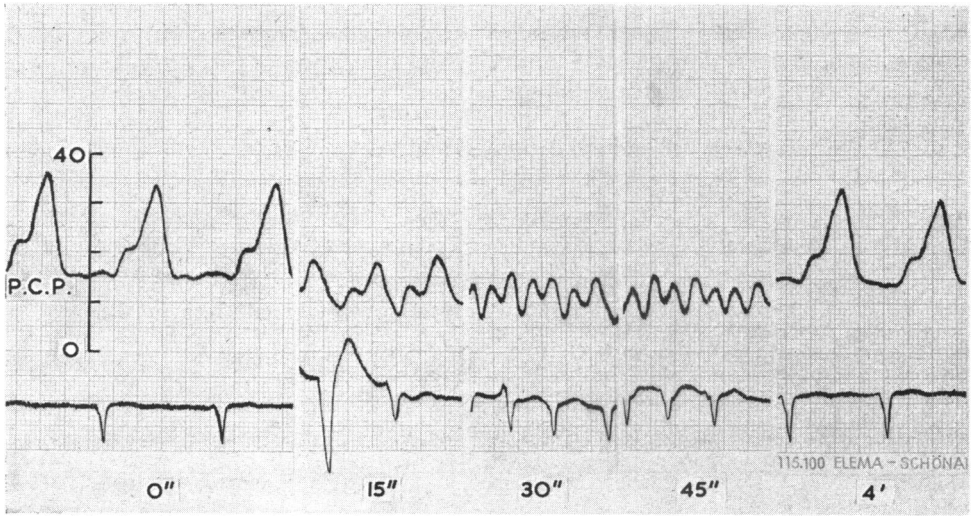

FIG. 4.—Pulmonary capillary pressure in mitral regurgitation. There was a fall in pressure after amyl nitrite.

occur. There are perhaps two reasons for this. First we cannot ensure that a sufficient dose of amyl nitrite has been inhaled. Secondly we know that in patients with severe heart failure the pressure response to inhaled amyl nitrite is less pronounced. Consequently the advantage of simultaneous pressure recordings from a systemic artery or left ventricle must be stressed (Endrys and Bártová, 1962). If blood pressure in the left ventricle or systemic artery does not fall and if tachycardia does not occur the test is invalid.

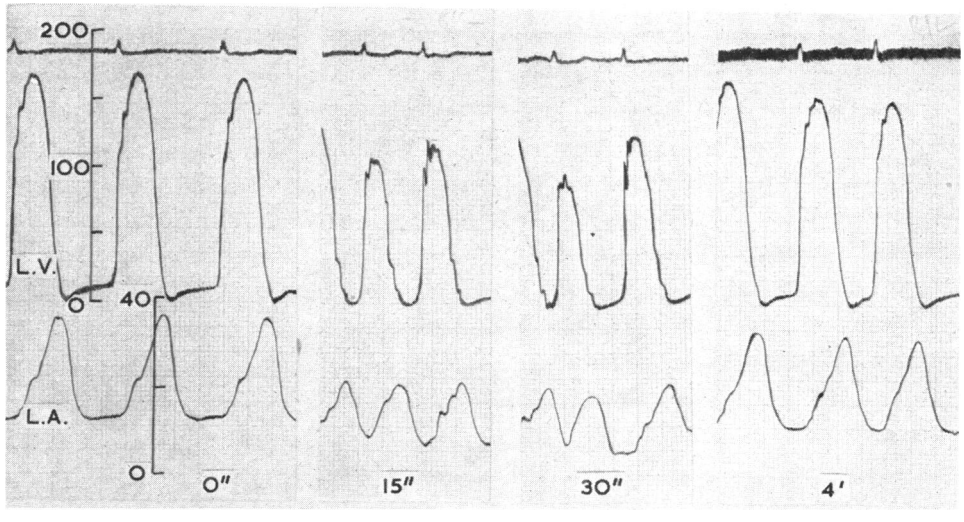

FIG. 5.—Simultaneously-registered pressure in left ventricle (L.V.) and left atrium (L.A.) in a case of predominant mitral regurgitation. After amyl nitrite there was a simultaneous fall in left atrial and left ventricular pressure.

SUMMARY

A test for distinguishing between predominant stenosis and regurgitation in combined mitral valve disease has been devised using amyl nitrite. After inhalation of this drug the pressure in the left atrium increased in all 18 patients with pure or dominant mitral stenosis. In all 9 patients with pure or dominant regurgitation, pressure in the left atrium decreased. The hæmodynamic causes of pressure changes after amyl nitrite are discussed and the drawbacks of the test are pointed out.

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ADDENDUM

Since this report was submitted for publication, 15 additional patients have been examined, with the same results. Two other patients failed to show any rise in left atrial pressure following amyl nitrite.